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ABSTRACT

Instructional technology needs to be carefully defined in order that educators do not make poor decisions about instructional strategy, and waste their limited resources because they lack a clear understanding of the principles that underlie the alternatives that will increasingly be open to them. This paper presents a list of the shortcomings of educational research and development. It suggests ways of using industry for educational research and development work while protecting the public interest. The paper also deals with maintaining quality control of educational products and services. The viewpoint of the paper is that of a private enterprise involved in education. (JY)

Instructional Technology: The Capabilities of Industry to Help Solve Educational Problems

by Robert W. Locke and David Engler*

We are pleased to offer this statement of our view of instructional technology, and by way of introduction should state the frame of reference in which it is written. First of all, our concerns are those of a business firm, and we therefore have something to say about the capabilities of industry to help solve the problems of education. Second, McGraw-Hill being among the more diversified of the education companies with respect to the media of instruction, we believe that we are relatively objective as to the efficacy of different kinds of instructional products, whether hardware, software, or combinations of the two. Third, we have become increasingly concerned about the preoccupation with educational products instead of educational processes. Finally, we have some strong convictions about the proper role of private enterprise in the public concern for education.

There are three sections in this statement. The first argues for a clear definition of instructional or educational technology. The second considers the disappointing state of R&D work in education. And the third argues the case for greater involvement of the businesses associated with education, suggesting some modified relationships that we believe would serve the public interest.

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The Need for Definition

We strongly urge the Commission to help clear up the confusion about what constitutes instructional or educational technology. (We use the terms interchangeably in this paper.) Most people involved in education, including the great majority of the teachers and administrators who will have to decide what changes to make in their teaching strategies, have only the vaguest notion of what educational technology is; and most make the serious but common error of defining it primarily in terms of hardware. This has greatly confused the issue because it has focused too much attention on the relatively superficial issue of what products are worth buying, and too little on the highly significant work being done through the process of instructional technology to produce teaching strategies that are relevant to the learning abilities of individual students.

The members of the Commission will, of course, be familiar with the various definitions of educational technology as a process, and perhaps should develop a new one in terms that can easily be understood by teachers and by intelligent citizens who are concerned about the schools. We suggest something along the following lines: Instructional technology is the process of applying the findings of behavioral science to the problems of instruction. This process manifests itself through the analysis of the relationship between subject matter content and student behavior both before and after instruction.

The importance of definition, it seems to us, is simply that educators will run the serious danger of making poor decisions about instructional strategy and of wasting their limited resources unless they have a clear understanding of the principles that underlie the alternatives that will increasingly be open to them. Their decisions are too often based on the characteristics of

hardware and software and too little on what their objectives are and how these can be best achieved. They are putting the cart before the horse.

We might cite a few cases to support this concern:

1. The programmed instruction movement has been seriously misunderstood by most observers, with the result that great misjudgments have been made about it. For some people the movement was an effort to use machines to teach--and indeed for a period in the early 1960's many viewed programmed instruction primarily in terms of teaching machines.

   When the machines turned out to have relatively little value, these same observers dismissed the entire movement as having little value. Others with a more sophisticated conception of programmed instruction realized that the machine was much less important than the program and were neither surprised nor discouraged when the machines failed. They came closer to seeing the process involved and therefore made more intelligent decisions.

   But very few people focused on the much more significant point that programmed instruction was one of the first attempts to develop a strategy of instruction based on the findings of behavioral psychology. Had the development of programmed instruction been seen by most educators in this light, rather than in terms of physical products like teaching machines and programmed books, it is quite probable that there would by now have been much more progress in the use of the technique in schools.

2. Enormous amounts of money have been spent on instructional television without (as yet) any really satisfactory judgments about its value. Most of the analysis of ITV has been in terms of teacher-student ratios, the relative costs of capital equipment and teachers' salaries, and the simple-minded assumption that a medium that has such proven capacity for entertainment (leaving aside questions of value) must have a great capacity for facilitating learning.

Very little of the analysis of ITV has been in terms of how well it can be adapted to an instructional strategy that takes into account the differences in learning style and rate. Again, the focus has been on the medium and not on the process of learning.

3. Perhaps most serious, the narrow view of technology as hardware, coupled with the serious doubts that many educators have about hardware, makes it that much more difficult to gain support for the promising work being done by behavioral technologists, who are beginning to apply the processes of technology to the development of improved instructional strategies. The work being done by people like Glaser at the Pittsburgh Learning Research & Development Center and by Flanagan at the American Institutes for Research is more promising than the work being done in, for example, computer-assisted drill and practice, but gets much less attention in the press and is less well understood by educators. This may be all right, but not if doubts about the ability of the schools to afford CAI make it more difficult to get support for the more basic work being done to individualize instruction. (For a good example of how a preoccupation with hardware and a failure to understand the process of educational technology can lead to pessimistic conclusions about the concerns of this Commission, see the article entitled "The Myths of Educational Technology" by Dr. Anthony Oettinger that appeared in the May 18 issue of The Saturday Review.

Since part of the Commission's charge is to advise the Office of Education, the Congress, and the people of the United States about how technology is likely to improve instruction, we consider it critically important for the Commission to develop and state its conclusions within the framework of a broad definition of instructional technology: that is, one that views it as a process.

The Shortcomings of Research and Development

It goes almost without saying that the U.S. educational system needs a better mechanism for research and development than it now has, and the Commission could make a major contribution by proposing some new approaches. There is too little research, too much of it is of low quality, too little is relevant to the most serious problems of education; and in general, there is too little direct relationship between research and implementation.

Furthermore, there is great confusion about what constitutes research, development, or implementation.

The following is an incomplete list of the shortcomings of educational R&D:

1. The amount of basic research is very small. By "basic" we mean research in learning theory, of the sort identified with Piaget, Bloom, Bruner or Gagne. Compared with basic research in the physical sciences, for instance, it is far too limited.

2. By and large, the best basic research has not been done in the colleges of education, which one would consider to be the logical source of educational research, but in the departments of psychology in universities--thus creating a communications barrier of some consequence. Happily, this condition has been somewhat alleviated in recent years as it has become respectable for other researchers to associate with their colleagues in the colleges of education.

3. Applied research, too, has been neglected. Much more of it is needed, and more of it should take place on a broader scale. What modest efforts have been made in recent years have tended to be fragmented into small projects. More experimentation on a scale comparable to, for example, the Oakleaf Project should be a prime objective.

4. The so-called education business has done too little R&D work. It has

done a great deal of experimental product development, often as a means of implementing research, but even this work could be done on a more rigorous basis. The education business has an R&D capacity that needs to be stimulated, both through the incentive of direct contracts and through the insistence of schools that products be properly evaluated. (More on this later.)

Since one of the great promises of instructional technology is its potential to help individualize instruction, the Commission should encourage broadened research and development in several critical problem areas. Experimental projects over the last few years have deepened our understanding of both the techniques and problems of individualized instruction.

From our vantage point, which is the design and development of instructional materials, we see a growing need for stronger theoretical bases, as well as applied techniques for dealing with the major factors of the instructional situation.

The three major factors with which the instructional designer must deal are:

1. The nature of the subject matter content;
2. The nature of the learner;
3. The nature of the learning environment.

The work done by Bloom and his colleagues on the taxonomy of educational objectives, and particularly the work done by Gagne on the analysis of learning tasks, have provided instructional designers with useful tools for analyzing subject matter.

What is needed now is a taxonomy of instructional strategy and media related to these taxonomies of learning tasks. Such a tool would help educators deal more rationally with the learning environment. It would, however, require the generation of substantial empirical data to serve as a base for the development of useful techniques.

We also need to improve our techniques of diagnosing individual learners. Our long-standing emphasis on standardized norm-referenced measures of ability and achievement are not adequate for the kind of individualized instruction now emerging in our schools. We need to strengthen our skills in diagnosing student behavior before instruction in terms of both mastery of prerequisite skills and prior mastery of stated instructional objectives.

Beyond this, we need instruments that will begin to help us diagnose differences in learning style so that we can effectively use the taxonomies of learning tasks, strategies and media in relation to the variations in the way different individuals learn different things.

Finally, there is a great need for broad experimentation with the techniques of cost-effectiveness or cost-benefit analysis in education. This will be increasingly true as we continue to individualize instruction and develop alternate instructional routes to accommodate differences in the way individuals learn. The useful application of these techniques to decision-making about instruction will provide educators with a badly needed tool for rational analysis of instructional problems.

It seems to us that these improvements in the technology of instruction will come about only with a broadened and deepened research and development effort. The Commission would make a major contribution by stimulating a high level of research and development in these problem areas.

The Role of Industry

Now for some special pleading. We hope that the Commission will consider the contributions that industry can make to education through applications of instructional technology. Despite the highly generalized assumption that industry has capabilities that can be used effectively in education, there has yet to be developed an acceptable rationale for its greater involvement, and this has inhibited both industry and education. The two key questions are a) how to use industry for educational R&D work, and b) how to maintain quality control of educational products and services. Implicit in both is the protection of the public interest.

R&D Work by Industry

It is reasonable enough to assume that the so-called education industry has the capacity to do worthwhile R&D work in areas connected with teaching and learning. However, it should be noted that the industry itself is highly diversified and that capabilities found in one firm may be quite different from those found in another; likewise there is a wide range of activities that make up the continuum from basic research in education to the development of practical applications. (It would be helpful to have a competent and thorough study of what capabilities exist in what kinds of organization.) Nevertheless, a few generalizations can be made about the capacity of industry to do R&D work, and they will suffice to make some other points.

First, industry has very little capacity to do basic research, and we feel that this function should be left primarily (although not exclusively) to the universities and other research-oriented organizations. Basic research in education is mainly research in learning theory, and we have already suggested that there should be more of it.

On the other hand, there is considerable capacity in inudstry to do applied research; for example, in the area of instructional media as it relates to

differences in individual learners and in subject matter content, as noted earlier in this paper.

Third, industry clearly has the capacity to apply research findings to experimental product development. In fact, the chief contribution of industry to the improvement of teaching and learning comes through its ability to translate the findings of research and creative experiments into products and services that have wide application in education.

Fourth, industry has some capacity for developmental work in new techniques that may be useful in education, such as cost-benefit analysis and systems analysis.

Fifth, industry has begun to develop the capacity to do evaluation studies, an activity that is heavily dependent on research techniques, and about which we will have more to say.

Finally, industry generally has the capacity to supply management for research efforts.

As noted earlier, the education industry is highly diverse, and different companies are likely to have quite different capabilities for educational R&D work. The fact remains, however, is that these capabilities do exist, and it is important that they be used to the best advantage of education.

There is no present mechanism through which the R&D capabilities of industry and the needs of education can be matched. The natural inclination of industry is to put its money where there appears to be the greatest market potential, but this is not always an area in great need of development. Essentially, the allocation of business resources is made according to the goals of the individual business firm which may or may not at a given moment be consistent with the goals of education. In this respect, the education industry behaves much like the consumer goods industry, making investment decisions based on

analyses of market trends, buying practices, competitive moves, and internal capabilities. However, the educational market differs greatly from the consumer market, in that it is public rather than private, and that it helps to accomplish societal goals. That is, education as a market for goods and services exists only because the public has created it, and has chosen to leave the production of goods and services to the private sector of the economy. Although schools are increasingly specific about what types of products they want to buy, they have only indirect control (through their buying decisions) over the characteristics of the products offered to them, and in common with other economic activities virtually none over the R&D decisions made by their producers.

This arrangement is not inherently bad, but we should recognize that it is not likely to result in an optimum match between the needs of education and the R&D capabilities of industry. In fact, it is almost certain to result in a time lag between the recognition of an educational need and the allocation of industrial R&D resources to the fulfillment of that need.

It seems to us that the interests of education would be better served - and the interests of the education business protected - if there were some mechanism for enlisting the R&D resources of industry in greater accordance with the needs of education. On the one hand, a strong case can be made for the maintenance of a strong and independent private industry devoted to the development and sale of goods and services for education; but on the other hand, perhaps the educational community should have more say in the priorities of the business firms.

To make the matter more difficult, education itself is less than unified in its determination of objectives and goals. Because of the highly decentralized nature of education - looking at it from a national standpoint - there are few effective means of agreeing on priorities. To be sure, there is fairly general agreement on the broad, critical needs, such as the improvement of urban education, the integration of the schools, and so on; but general agreement on areas

that have become critical is very different from the development of discrete goals that have the potential to make significant improvements in education. It is difficult to build an R&D program around such a generalized goal as improving urban education, just as it would be difficult to build R&D programs in the defense area around a generalized goal like preventing World War III.

We need, therefore, a means of analyzing the needs of education on a systematic and national basis; and then of influencing the allocation of R&D sources according to these needs, whether the resources are in education itself, in non-profit research organizations, or in industry. Further, whatever mechanism is developed for this purpose, it needs to be structured in such a way that the independence of local or state educational units is not jeopardized.

This last, it seems to us, makes it difficult for the Office of Education to be the main arbiter of educational priorities. Even if the Office could be staffed in such a way that it clearly had the competence to do the job, it seems neither likely nor proper to us that the Congress should place this responsibility solely in the hands of a powerful agency of the federal government; and there is clearly a reluctance among state and local educational officials to see much more authority given to the Office.

Therefore, we believe that some new mechanism needs to be created, and we are impressed by the recommendations made in the recent CED report, Innovation in Education, that there be created a national Commission on Research, Innovation, and Evaluation in Education, supported by but not controlled by the federal government. If an agency were created for the purpose of influencing and contributing to the R&D work done in education, if it were adequately financed and received its support from both the federal government and the private foundations, and if it were governed by a prestigious board of directors chosen on a basis that assured its independence, then we believe this agency could do

much to help match the educational R&D resources of the country to our long-term educational needs.

Returning to the matter of R&D in the education business, such an agency could also be the vehicle through which R&D contracts could be made with private industry, since such arrangements would be consistent with an analysis of what resources are applicable to what problems, and because they would avoid the difficulties of direct contracts between federal agencies and private industry in the area of education. (The sensitivity of Congress and the various federal agencies to the matter of R&D contracts with industry strikes us as highly naive as to the intentions of the business community, but we see no sign that it is likely to change.)

Dissemination by Industry

The power of the education industry to disseminate new applications of R&D work in education is very great, and in fact remains the chief means by which new techniques for teaching and learning reach the teachers and students. Properly used, this dissemination or marketing capability can make important contributions to education. The problem is to influence it without controlling it. Again, we see a need for a new mechanism, to which the proposed Commission on Research, Innovation, and Evaluation could make an important contribution.

Schools, colleges, and other educational institutions are entirely free to buy whatever teaching and learning systems they consider best suited to their particular needs (subject only to the limitations of local economics and occasional forms of local censorship), and any attempt by a national agency to influence or control these local buying decision would clearly be a violation of our policy of state and local responsibility for public education. Therefore, it may be more effective to influence the sellers than the buyers, and we suggest that this can be done through the development of standards for both the development and representation of educational products.

The need for standards was not so great when the choice of teaching and learning materials was limited largely to textbooks. All teachers have used textbooks as students and taught from them as teachers, and have a generally adequate frame of reference with which to make wise selections. However, the development of newer and less conventional forms of teaching and learning materials and systems presents teachers and schools with the problem of making choices without adequate frames of reference. Teachers who know what to look for in textbooks find it difficult to evaluate programmed materials, and even more difficult to decide whether or not equipment-based learning systems are appropriate to the needs of their students. Thus, the development of the new instructional technology carries with it the growing need to help educators make wise purchasing decisions.

We feel that the best solution to this problem is for the producers of educational materials and systems to develop standards for the evaluation of their products, and for educational institutions to insist on being given the data derived from field testing. Ideally, each new instructional program should be designed around a carefully developed set of behavioral objectives - that is, what learning it should facilitate for what kinds of students, and under what conditons - and then tested in actual classrooms during its formative stages in order to measure its effectiveness and to determine how it can be improved. Then the detailed statement of behavioral objectives and the field-testing data should be written up in a technical manual. The manual would help potential users determine how closely the objectives of the program match those of the school and students for which it is being considered, and the data would provide reasonable evidence as to its effectiveness under specified conditions. Technical information of this type is commonly provided by the publishers of standardized educational tests, and there is no reason why

it cannot be supplied by producers of instructional systems. Some, in fact, are beginning to do so, and it is the firm intention of McGraw-Hill to publish evaluative data for new programs with increasing consistency.

This approach to evaluation would help the producers to maintain quality control and the schools to make intelligent buying decisions. Further, because it would be a form of self-policing, it would leave both educational companies and schools with a maximum of independence. It would avoid the pitfalls of using some central agency to monitor either the production of instructional systems or the purchasing decisions made in education.

However, it is unlikely that this ideal state of things will be reached in the near future. The cost of evaluation is sufficiently high that education companies may be slow to undertake it on the scale suggested here, and the technical problems of evaluation are probably beyond the present competence of all but the most sophisticated producers of instructional systems. Therefore, it would be highly beneficial if some combination of both pressure and assistance could be applied to the problem, and we see this as another highly useful function of the sort of agency proposed by the CED.

Such an organization could perform two services in the area of evaluation that would greatly help its progress without seriously limiting the freedom of action of either the education companies or the schools and colleges. The first would be to undertake studies of the process of evaluation itself, in order to provide the producers with some technical assistance that they badly need. The second would be to show schools and colleges how to interpret evaluative data, and more important, how to determine their own instructional objectives with enough sophistication to create a framework within which to consider the new instructional systems being offered to them. Both services would apply indirect pressure on the companies and schools to get on with the job, and at the same time would help them do it.

In Conclusion

Several different and largely unrelated developments in education have combined to create an unusually good climate for change. Much the most important of these developments is that behavioral psychologists are beginning to understand the different ways in which people learn. Of less but still great importance are a) that developments in the media of instruction (from films to computers) have created new options for the individualization of instruction, b) that the public increasingly recognizes the key role played by education in the achievement of social, economic, and technological goals (from getting a man to the moon to solving the problems of the cities), c) that we are willing to use the broad taxing power of the federal government to help finance change in education, and d) that the education business has acquired new capabilities. Instructional technology is one of the chief means by which change will take place, and as a process has great potential to bring about change in a much more systematic way than has generally been possible in the past. From the standpoint of national policy, therefore, it would seem to us highly advisable to foster a climate in which the maximum resources will be allocated to the improvement of education by all of the segments of society that can make a significant contribution, including the various parts of education itself, the major government units at the federal, state and local levels, the non-profit R&D organizations, and the business community associated with education. The greatest single need is for competent research in the design of instruction, and effective means of implementing research findings in the classroom.

Research in the design of instruction and its implementation in the classroom, however, must be done in the delicate political climate that pervades education. While virtually all of public elementary and secondary education

and much of public higher education is controlled at the state and local level, it makes little sense for R&D work in instructional design to be done for purely local purposes. This makes educational R&D more difficult to administer than, for instance, defense R&D, and considerably more sensitive politically. And yet, unless the present R&D effort in education is both expanded considerably beyond its present levels and also coordinated in at least some informal way, there is a real danger that the opportunity to improve education will be dissipated.

More than anything else, we urge the Commission on Instructional Technology to examine the issue of how to research in instructional design can be furthered, and how research findings can best be implemented in a highly decentralized educational system. Speaking for our own interests, we believe that the education companies are capable of playing a major role in both the design of instruction through R&D work (more D than R), and in the implementation of instructional innovation through dissemination to the schools. We recognize, of course, that our business is the private sector of a public enterprise and that greater involvement will mean more subordination to public control. The problem will be to devise relationships between the public and private interests in education that provide the greatest natural incentive to work for the public good.